New Products

New monitors now available for the 3500 Machinery Management System

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Turbine Supervisory Instrumentation (TSI) Systems continuously monitor and measure a wide variety of supervisory parameters to provide complete machine protection and management. Turbine Supervisory Instrumentation provides monitoring, diagnostic and predictive maintenance information necessary for managing turbine generators and other critical machinery. Bently Nevada's advanced 3500 Machinery Management System has been expanded to include additional TSI functions.

3500/50 Tachometer

Rotor speed monitoring is crucial for machinery protection and management. Several different types of speed measurement are required, depending on machine requirements. These include:

- Speed indication
- Setpoint alarming
- Speed band alarming
- Zero speed notification
- Rotor acceleration

Speed indication

With any type of machine, a primary concern is how fast the machine is running. Typically, speed is displayed in the control room on some type of machine control display. It is often necessary to display the machine speed somewhere else in the plant, such as at the machine skid. A speed monitoring device, capable of supplying outputs to such a display, is required.

Setpoint alarming

There are two main uses for the setpoint alarm function within a tachometer module. The primary use is to provide operators with an indication when a machine is operating above or below its design speed. The second use is to notify support equipment when operating conditions are changing. Support equipment usually requires a contact closure to notify it that the other machine is being shut down. An underspeed alarm can provide this.

Speed band alarming

Rotating machinery typically has balance resonances (critical speeds) that, if operated within, can cause increased vibration. In some cases, process conditions or startup sequences can cause a machine to operate within this range. If this were to continue for prolonged periods of time, machine damage could occur. Operators need an alarm to alert them to this undesirable condition.

Zero speed notification

Most steam turbines in use today require a turning gear to keep the machine on slow roll, so shaft bowing does not occur. Shaft bow could result in machine damage during a subsequent machine startup. A zero speed notification (typically less than 5 rpm) must either drive a relay that automatically engages the turning gear or provide an alarm which indicates that the operator should engage the turning gear.

Rotor acceleration

Indication of rotor acceleration is used when starting steam turbines. The steam turbine manufacturer supplies starting and loading instructions that must be followed. One of the key variables is rotor acceleration. Rotor acceleration is used by the operator during this startup procedure to ensure that maximum acceleration for the turbine is not exceeded.

Tachometer options

The 3500/50 Tachometer can include all of these speed measurements. It can be configured with three different options:

- Speed monitoring, setpoint alarming and speed band alarming
- Speed monitoring, setpoint alarming and zero speed notification
- Speed monitoring, setpoint alarming and rotor acceleration

The 3500/50 can be configured to supply conditioned Keyphasor® signals to the backplane of the 3500 rack for use by other monitors, eliminating the need for a separate Keyphasor module in the rack. The 3500/50 can be configured to drive 3500 Relay Modules. Tachometer data can be displayed in the following ways:

- Through the 3500 Communications Gateway to a Distributed Control System (DCS)
- Through the 3500 Communications Gateway to a remote or local Modbus® Display Panel
- Via the recorder outputs (4-20 mA signal) to a remote or local display

Bently Nevada 3500/50 Tachometers are not designed for use independently as, or as a component of, a speed control or overspeed protection system. These monitors do not provide protective redundancy and the response speed needed for reliable operation as a speed control or overspeed protection system. A reliable overspeed protection system requires the 3500/53 Monitor.

Where provided, the analog proportional output is suitable for data logging, chart recording, or display purposes only. Also, where provided, speed alert setpoints are suitable for annunciation purposes only.

3500/60 and 3500/61 Temperature Monitors

One of the most requested additions to the 3500 Machinery Management System is temperature monitoring. To effectively monitor turbomachinery, several machinery parameters need to be measured. The more common measurements are vibration and thrust. Many end-users also incorporate temperature measurements, which include bearing metal, lube oil, and seal oil temperatures. Typically, there are three ways to access temperature data. The first is to establish a walk-around program in which operators manually record temperature readings on a periodic basis. The second is to pull the data directly into the Distributed Control System (DCS) through devices that are independent of the machinery protection system. The third method is to incorporate temperature measurements into the machinery protection system and provide the information to the DCS via a Serial Data Interface.

Walk-around program

Information from auxiliary equipment is usually displayed locally at the machine in a panel. Many of these auxiliary systems do not have a direct link to the DCS. Therefore, walk-around hand logging and hand plotting of the data is necessary. Troubleshooting a machine problem that requires correlation of temperature and vibration data can be very difficult. Customers have reported that it took four to five days to correlate data to solve a problem that could have been solved in minutes if vibration and temperature data had been available in one system. Even greater cost savings can be realized by eliminating the walk-around program.

Integration with the DCS

When temperature data is acquired at the DCS through devices unrelated to the machinery protection system, the data may have different time stamps. This could make it difficult to correlate temperature data with vibration data. Furthermore, additional wiring for this equipment can be expensive. Integration of temperature measurements into one machinery monitoring system simplifies overall installation and provides a way to send all machine-related data to the DCS via the same connection. In many cases, temperature data is more valuable if it is sampled along with vibration and thrust data at the same delta rpm. During machine startup and shutdown, this correlation of data can be valuable for understanding machine conditions.

Temperature options

The 3500/60 and the 3500/61 Temperature Monitors provide a cost-effective way to integrate temperature measurements into the 3500 Machinery Management System. One integrated system can now supply temperature and vibration data via a common link to the DCS. Installation costs are lower and separate interface devices along with the associated wiring are no longer necessary.

Each 3500 Temperature Monitor accepts six channels of temperature input. Its various I/O modules support non-isolated RTD and TC inputs and isolated TC inputs. The 3500/60 is more cost-effective for DCS integration because it does not have recorder outputs. The 3500/61 offers easy DCS integration and recorder outputs. Both temperature monitors support the following transducer inputs:

- Type E, J, K, T Thermocouple
- 100Ω 3-wire & 4-wire platinum RTD ($\alpha = 0.00385$)
- 100Ω 3-wire & 4-wire platinum RTD ($\alpha = 0.00392$)
- 120Ω 3-wire & 4-wire nickel RTD
- 10Ω 3-wire & 4-wire copper RTD

The 3500/53 Overspeed Protection System

There is a major trend currently taking place in the turbine industry. OEMs (Original Equipment Manufacturers) and end-users are removing mechanical overspeed protection systems (OPS) from both steam and gas turbines. These groups are moving to more reliable, cost-effective electronic OPS instead of outdated mechanical systems. Many turbines today incorporate an OPS in their control systems, and also provide a highly reliable, secondary OPS. It is common knowledge that best engineering practices will specify an electronic OPS system. This practice is backed by standards, such as API 612 - Special Purpose Steam Turbines for Petroleum, Chemical and Gas Industry Services. API 612 also specifies that turbine control and OPS be separate systems.

Bently Nevada now offers an Overspeed Protection System for our 3500 Machinery Management System. The 3500 System is a highly reliable platform that now has a fast-response, redundant tachometer system that can be used for overspeed applications. The 3500 platform allows a high degree of system flexibility. Users can outfit an entire machine train with vibration measurements and overspeed protection within a single system that can supply its data to a Distributed Control System.

Overspeed event consequences

An overspeed event can occur in 50 milliseconds or less if turbine load is lost instantaneously. A turbine overspeed event is a very hazardous condition because the turbine usually sustains significant damage. The consequences of an overspeed event in a steam turbine are generally more serious than in a gas turbine. At very high speeds, a steam turbine will burst and release high pressure steam, which results in the destruction of the machine, collateral damage, and possibly injury or loss of life. While overspeed events in a gas turbine do not generally invoke as much secondary damage, extensive machine damage can occur. This provides justification for equipping gas turbines with overspeed protection systems. Obviously, overspeed is not an event that can be corrected by human intervention. A highly reliable automatic system, that trips the turbine immediately upon sensing an overspeed event, is required.

Electronic versus mechanical Systems

Mechanical overspeed systems have many inherent problems. Testing that is required for periodic verification is difficult and time-consuming. Normally, the machine must be taken off-line, disconnected from its load, and run at overspeed to verify that the spring-loaded bolt extends properly, to shut down the turbine. There may be many instances when testing is not possible, or can take days to perform, resulting in a significant impact on production. Testing a mechanical system requires the user to run the turbine in an overspeed condition to ensure that the mechanical system actuates. Operating the turbine above its specified design speed unnecessarily risks machine failure. Often, this procedure is iterative (repetitious), which further subjects the machine to potential damage. Finally, after tuning the mechanical system, factors as common as shaft vibration can affect the accuracy and repeatability of the mechanical system. Mechanical systems are also prone to friction, wear, and environmental damage, such as corrosion and rust. In most cases, it is also difficult to make a mechanical system redundant.

Electronic Overspeed Protection Systems are comparatively easy to test. If the system is properly configured, it can be tested with the machine online. A signal generator input can verify the system's accuracy and simulate an overspeed event. An electronic system can also be designed for greater fault tolerance than a mechanical system. A three channel OPS can be designed so no single-point failure will cause a false or missed shutdown. Bently Nevada's 3500 OPS allows vibration monitoring in the same system, for tighter integration of the overall protection system. If the system has a Serial Data Interface, it can communicate information to a Distributed Control System.

Industry trends

OEMs are realizing significant savings by replacing mechanical OPS with electronic OPS. OEMs of general-purpose, steam turbines have saved substantial design and manufacturing costs by eliminating the mechanical OPS. Large steam turbine manufacturers can save even more money.

The end-users of turbines equipped with mechanical OPS can also reduce maintenance costs. Many turbines in use today are based on 20 to 30 year old technology. These end-users often find that it is very costly to replace mechanical OPS parts, because they are no longer commercially available, and must be specially built. Many of the control systems for these machines are being updated with more sophisticated control systems. End-users often find that this is an optimal time to replace mechanical OPS with electronic OPS. In today's work environment, where people are doing more with less, reduced testing means reduced costs.

API 612

API 612 specifies that an overspeed shutdown system be composed of a least two separate electrical circuits and that the system be independent of the governing system. The system must also prevent the turbine rotor speed from exceeding 127% of the rated speed when instantaneous inertial load is completely lost under operating conditions. The OPS must be fault tolerant, and be able to electronically test the system on a periodic basis.

OPS options

The 3500 Machinery Management System is a very reliable platform. Incorporation of the 3500/53 OPS into this system will provide the utmost in machine protection and management. The 3500/53 is extremely flexible to accommodate different customer needs. As with the entire 3500 platform, the 3500/53 is software configurable. Some of the features and functions of the 3500/53 are listed below:

Two or three-channel systems

The 3500/53 offers both two and three-channel systems. Either configuration provides a fault tolerant system. The three channel system is the preferred application, for the highest degree of fault tolerance for this critical protection parameter. However, the system is flexible enough to accommodate a 2-channel system if a 3-channel system is not feasible.

Transducer OK check

The 3500/53 checks all transducers for missing or extra pulses and can verify that the probe is operating within OK limits.

Independent or dependent voting

Each 3500/53 can supply independent relay outputs to an external voting device (independent voting). It can also vote in a 2-out-of-3 or 1-out-of-2 fashion to drive its own relays to initiate shutdown.

Onboard testing

The 3500/53 comes equipped with an onboard frequency generator to allow easy testing of the system.

Normally Energized (NE) or Normally De-energized Relays (NDE)

NE relays allow the user to configure the relay to change state on loss of power. NDE relays change state when power is supplied.

Latching or Non-latching Alarms

The user can configure what the state of the alarm is when the alarm condition is removed. The user can reset latched alarms manually or via the software.

Integrates with DCS

OPS data is available to a DCS either through a Serial Data Interface or it can be X-windowed with the 3500 Operator Display Software. Data available is:

- Current speed
- Peak speed
- Alarm status
- OK status
- Alarm setpoints
- Software switches

The 3500/53 Overspeed Protection System is a highly reliable protection system that is single point fault tolerant. It meets the requirements of API 612 and allows clean integration of an overall machinery management system for your turbines. A removeable 3500 Machinery Management System insert is included in this issue. For additional information, contact your nearest sales and service representative or check the appropriate box on the reader service card. ■

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